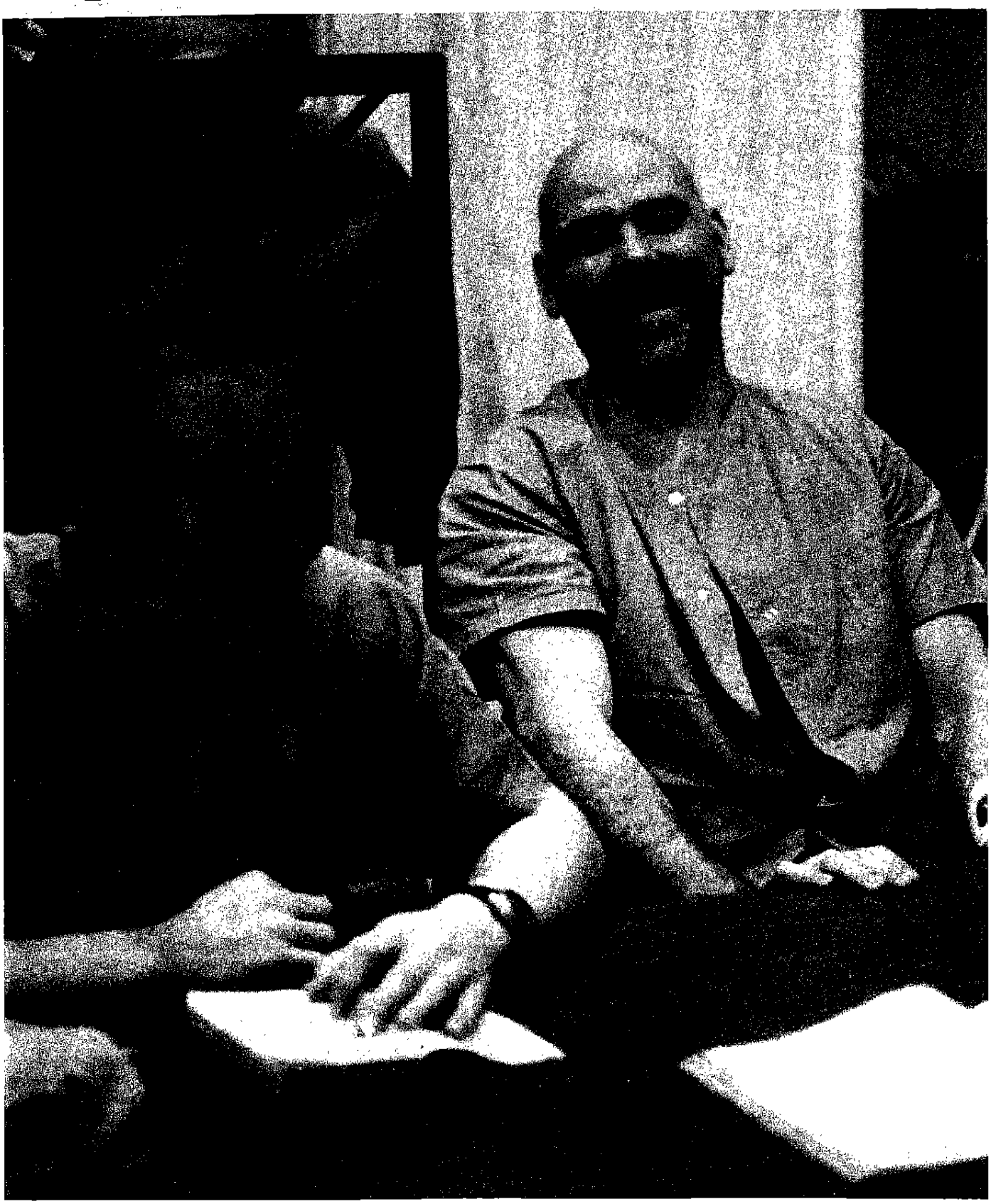
Diving

Rapture of the Deep!

NOAA reprint
National Oceanic and Atmospheric Administration
VOLUME 12 NUMBER 4 FALL 1982



Drunk Diving

Rapture of the Deep!

Jack Stringer

It felt like someone sticking a knife in my knee," said Marc Kaiser nearly 3 days after he had "surfaced" from 200 feet below sea level in the thick-walled hyperbaric chamber at Duke University.

"There were shooting pains everywhere. In my knees, shoulder, and hips..."

Kaiser was one of ten divers from NOAA who was sealed into two small pressure chambers for 9 days to help researchers study nitrogen narcosis or "rapture of the deep"—a condition similar to inebriation which could seriously affect a diver's safety.

Kaiser compared nitrogen narcosis to the effects of a three double-martini lunch. "You may believe you are functioning normally but you're not," he said. "You're acting as if you are intoxicated and it takes a considerable amount of concentration to perform simple intellectual and mechanical tasks.

To a diver, who must constantly be in top shape physically and mentally in the alien and sometimes hostile undersea environment, a moment's inattention, a few seconds delay, a slight hesitation when prompt action is called for, can spell disaster. The divers at Duke were to expose themselves to nitrogen narcosis to study this deadly malady and pass on what they learned to fellow divers throughout the world.

The diving study was financed by the commercial diving firm Oceaneering International, Inc., of Houston. NOAA provided nine divers, and a tenth diver was recruited from the Navy.

Dr. Peter B. Bennett, director of the Duke University's F. G. Hall Environmental Laboratory which houses the world famous hyperbaric chamber, said the divers breathed a special nitrogen-oxygen mixture.

Daily Tests

"Each day, the divers' performance ability was tested to measure how well the diver could remember, do simple arithmetic, and other intellectual tests," he said.

Researchers believe that nitrogen subjected to undersea pressure affects the chemical properties of the nervous system, resulting in a feeling of intoxication and impaired intellectual and mechanical abilities. At present, this intoxicated state makes it impossible for divers to complete simple tasks, such as welding, at depths deeper than 150 feet.

Above, Lt. (jg) John W. Blackwell quickly adapted to nitrogen narcosis, and failed to experience many of its symptoms of intoxication.

Although research dives such as the one at Duke University are obviously important milestones for recreational divers, they have a wider significance.

Presently, compressed air diving stops at about 150 feet because of the narcotic effect of the nitrogen. However, when the Duke study proved that some divers can adapt to the nitrogen and work effectively at depths greater than 150 feet breathing compressed air, its commercial application was apparent. Compressed air now can be substituted for the expensive non-narcotic helium-oxygen, greatly reducing diving costs without affecting diver safety.

Problems with Helium

The problems of transporting and storing large amounts of helium gas also are major drawbacks, particularly for offshore oil rigs. Aside from the safety factor, compressed air is easier to deal with, and does not have some of the intrinsic problems helium has in deep diving operations.

Diving at deeper depths is increasingly important for the economic stability of the United States. Resources such as petroleum, minerals and food are gradually running out as the world population increases dramatically. The ocean floor which equals about 70 percent of the planet should help restore these depleted resources in the years to come.

"There is no question that the oceans are our greatest untapped resource," Bennett said. "Any way we can learn to adapt to live and work under the seas is a significant step to the present and future utilization of the ocean's resources."

The test went better than Bennett and Dr. David Youngblood, principal investigator for Oceaneering International, had anticipated. "There were two phases of improvement," said Youngblood. "The first one occurred after a few hours, and this we believe to be an adjustment to the state of narcosis and not a true reduction in narcosis.

Danger In The Depths

"At greater (than 100-foot) depths the majority of compressed air divers show impairment of thought, judgment, reasoning, memory, and ability to perform mental or motor skills .... The diver may have feelings of elation and well-being (euphoria) and a sense of detachment from the environment accompanied by a dangerous overconfidence, an uncontrollable desire to laugh, and a tingling and vague numbness of the lips, gums, and legs. There may be an inability to make correct and rapid decisions or to concentrate effectively on a task. Errors may be made in recording or compiling data or computations. Novices, especially, may develop terror rather than euphoria. Narcosis is a significant danger to divers because it not only increases the risk of accident but diminishes the ability to cope with an emergency."

Excerpt and chart from
NOAA Diving Manual

Narcotic Effects of Compressed Air Diving

(30-100 ft)	Mild impairment of performance on unpracticed tasks. Mild euphoria.
(100 ft)	Reasoning and immediate memory affected more than motor coordination and choice reactions. Delayed response to visual and auditory stimuli.
(100-165 ft)	Laughter and loquacity may be overcome by self control. Idea fixation and overconfidence. Calculation errors.
(165 ft)	Sleepiness, hallucinations, impaired judgment.
(165-230 ft)	Convivial group atmosphere. May be terror reaction in some. Talkative. Dizziness reported occasionally. Uncontrolled laughter approaching hysteria in some.
(230 ft)	Severe impairment of intellectual performance. Manual dexterity less affected.
(230-300 ft)	Gross delay in response to stimuli. Diminished concentration. Mental confusion. Increased auditory sensitivity, i.e., sounds seem louder.
(300 ft)	Stupefaction. Severe impairment of practical activity and judgment. Mental abnormalities and memory defects. Deterioration in handwriting, euphoria, hyperexcitability. Almost total loss of intellectual and perceptive faculties.
(300 ft)	Hallucinations (similar to those caused by hallucinogenic drugs rather than alcohol).

(Derived from Edmonds, Lowry, and Pennefather 1976.)

Life in the chamber included mid-morning snacks from clinician Norma Mann and a birthday party

Some Divers Adapt

"The second period of performance improvement occurred after several days in which a large percentage of the divers showed a significant improvement in their test scores, an improvement believed to be a true physiological adaptation to high nitrogen pressure."

Some individuals showed no improvement and remained in a state of significant narcosis throughout the study. Others still felt the narcotic effect of the nitrogen, but could control it, and towards the end of the study, showed significant improvement.

Because the volunteers were all trained divers, they were accustomed to diving, but not necessarily being enclosed in a pressure chamber for 9 days. It was not, therefore, an unusual experience for them, but it was quite unique to have ten people living inside two chambers, six in a 20-foot-diameter sphere and four in a cylinder 12½ feet long and 10½ feet wide. The chambers were interconnected by a tiny third chamber.

Dr. J. Morgan Wells, director of the NOAA Diving Office in Rockville, Md., and one of the volunteer divers said that they were trying to help solve a physiological and challenging problem: Will divers adapt to compressed air intoxication? Until now, little if any data existed as to the effects of adaptation to the narcosis at depths greater than 150 feet for more than 5 successive days.

Wells said that the results of the test indicated the need for thorough screening and pretesting of divers prior to conducting operational dives at 200 feet for an extended period.

"Most of the divers were responsive in a number of testing areas," he said. "Four divers, however, like Kaiser, suffered from the 'bends' shortly after leaving the chamber or during its 'ascent'."

"Narked" for 5 Days

Diver Robert Smart, a commander in the NOAA Corps said, "I stayed just as happy as a bug in a rug for 5 straight days." When the 38-year-old officer finally got back to the surface and was allowed to see some of the graded results of some of the tests, he discovered that he was one of the most "narced" people in the group.

"I had no idea that my efficiency had been impaired that much," he said.

Narcosis really begins to manifest itself at about 130 feet. Diving much deeper than 130 feet using scuba, the risks of narcosis and other risks are greatly increased.

Smart acknowledged that narcosis begins to take affect in a very subtle manner which was evident in the diary he kept while in the chamber.

Monitoring the tests was Dr. Peter B. Bennet, but the major activity at a simulated 200 feet below sea level was reading. Participants included (first row) Steven Urick, Lt. (jg) John W. Blackwell, Lt.(jg) Robert W. Maxson, Cdr.John C. Albright, (second row) Cdr. Robert V. Smart, Marc Kaiser, Lt. Stanton M. Ramsey, William Phoel, Dr. Paul Barry, and Dr. J. Morgan Wells.

Interspersed with his philosophical reasoning concerning the development of the human nervous system and its adaptation to environmental conditions, there were strange, equivocal fantasies in which he had become a primitive, club-wielding caveman.

"The effect I felt," Smart said, "was definitely moving me back."

Macho But Risky

Smart believes the results of the Duke study will help keep a few divers alive. "It's a macho thing," he said, "to dive to 150 feet. I now know the risks!"

When Marc Kaiser came out of the chamber, he said he really felt good. But 68 hours later when he got out of the plane at Miami airport, he had "shooting pains in his knees, shoulders, hips, and everywhere."

At NOAA's div. y office in Miami, Kaiser was put on "Table 6," a decompression sickness treatment schedule, for five treatments over a 2-week period. The sixth treatment was on the osteomyelitis table at 45 feet for 110 minutes. Today, Kaiser is riding his bike 20 miles daily, hangs for 10 minutes by his feet in his inversion boots, and does at least 30 situps from that position. He suffers no ill effects.

The youngest diver in the group, 22-year-old Steve Urick said it was his first saturation dive. "During the first 5 days, everything amused me," he said. "When we began our ascent, I realized that I had been narced out."

On the third day of Urick's ascent, his leg went numb, and he was put on the laboratory's Table 6 and run down to 60 feet breathing 20-minute periods of oxygen and 5 of air. These were gradually decreased to 30 feet where he had the same breathing periods for 5 minutes.

"My interest and willingness to continue diving has not been affected," Urick said. "I am, however, more concerned about narcosis."

Since it was found that some divers can dive under water at greater depths without breathing more expensive gas like helium-oxygen, the safety and cost effectiveness for a commercial or recreational diver is apparent. If compressed air is used, all that is needed is a compressor.